Measurements of the Positions of the Detectormodules of the EMC FWEC

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2. Measurement equipment
3. Measurements for each detector module
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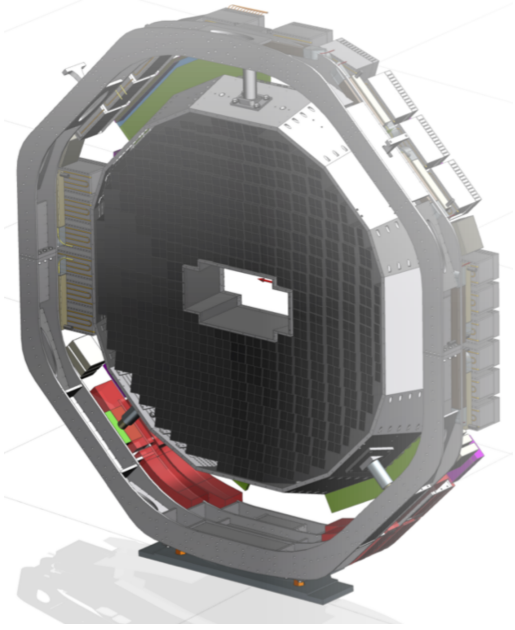
5. Position of the EMC Forward Endcap

Structure of the EMC Forward Endcap

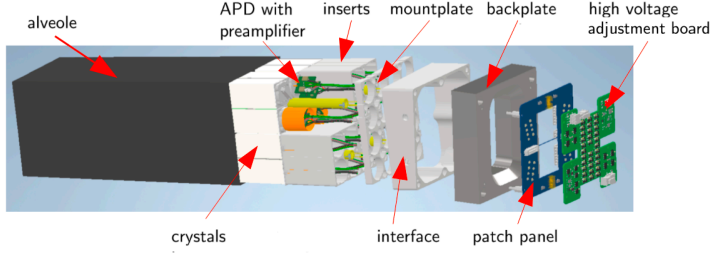
EMC Forward Endcap

- 3856 PWO-crystals
- Grouped in modules of 16 or 8 crystals
- Cooled to $-25\,^{\circ}\mathrm{C}$ to increase lightyield
- Insulation not shown in picture



EMC Forward Endcap

- Aluminium inserts pushed into carbon fiber alveole
- Mountplate screwed to inserts
- Inserts glued to alveole after assembly
- Mounted with individual interface piece to the backplate



Measurement equipment

Leica AT-960, T-Probe and T-Scan

Leica AT-960LR Lasertracker

- Position measurement with reflector, T-Probe or T-Scan
- Accuracy $\pm 15\,\mu m \pm 6\,\mu m/m$
- Range 40 m

Leica AT-960, T-Probe and T-Scan

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Leica T-Probe

- Different measurement tips available
- Accuracy $\pm 35\,\mu m$

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Leica T-Probe

- Different measurement tips available
- Accuracy $\pm 35\,\mu m$

Leica T-Scan

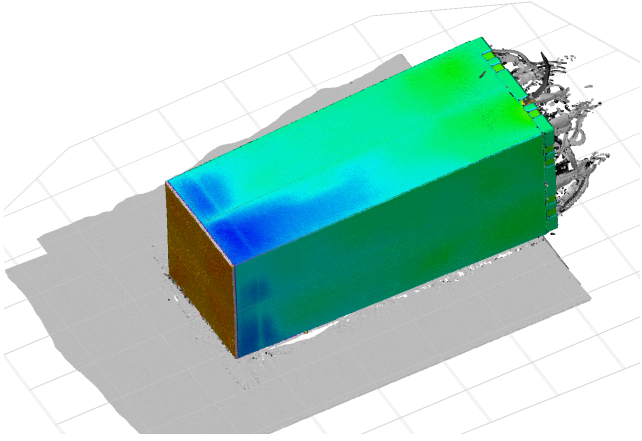
- Laserscanner for surface measurements
- Accuracy $\pm 60\,\mu m$

Measurements for each detector module

Geometry Measurements of Forward Endcap Submodules

Measurements

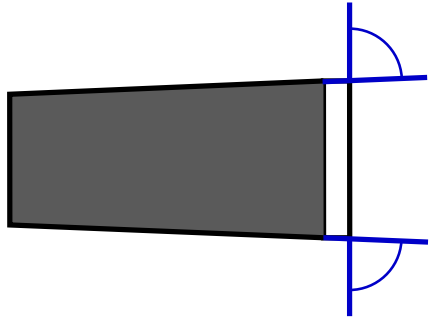
- Measured using T-Scan Line Scanner
- Alveole sits on flat surface
- All visible sides are scanned
- Pointcloud of 2.5 million points
- Pointcloud is compared to a CAD-model
- Deviations to the model are extracted



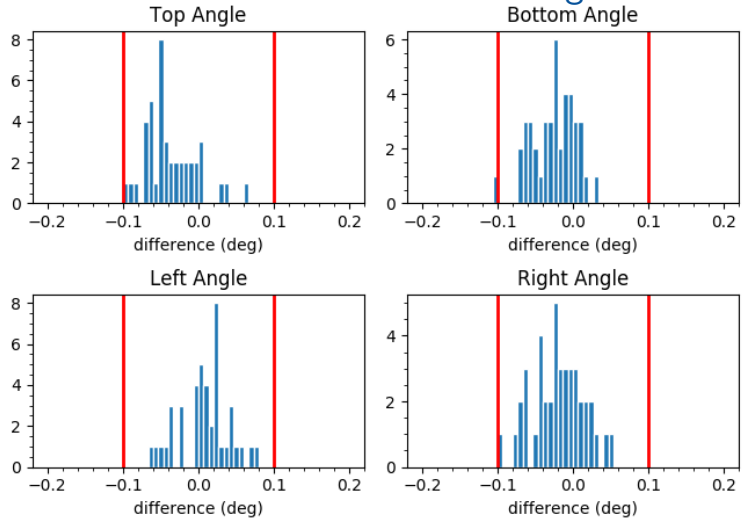
Definition of Angles

- Angle between carbon fiber alveole and back of the alveole
- Four different angles, one for each side
- Nominal value of 89.07°

- Direct measurements for top, left and right side
- Indirect measurement for bottom side
- Only deviations shown
- Negative deviations move tip to the center
- Positive deviations move tip to the outside
- 0.1° corresponds to 0.5 mm



Distribution of measured angles



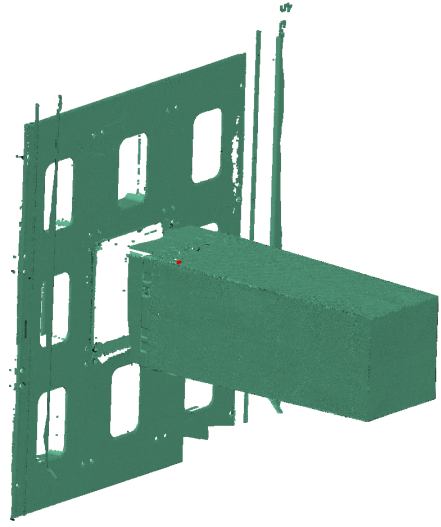
- Measured angles of glued alveoles
- Red lines correspond to half the distance between alveoles

Measurements on a backplate mockup

Position Determination by Frontface

Procedure

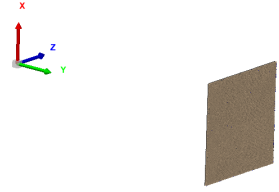
- Scan submodule on the backplate



Position Determination by Frontface

Procedure

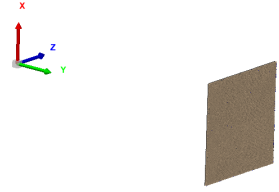
- Scan submodule on the backplate
- Select points of the frontface



Position Determination by Frontface

Procedure

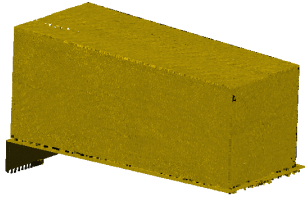
- Scan submodule on the backplate
- Select points of the frontface
- Create a mesh an use it as reference



Position Determination by Frontface

Procedure

- Scan submodule on the backplate
- Select points of the frontface
- Create a mesh an use it as reference
- Import scan from table



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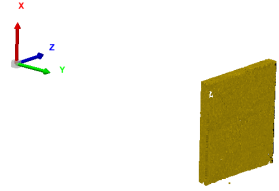
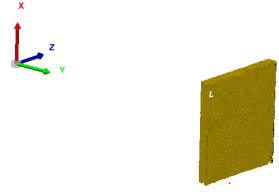


Position Determination by Frontface

Procedure

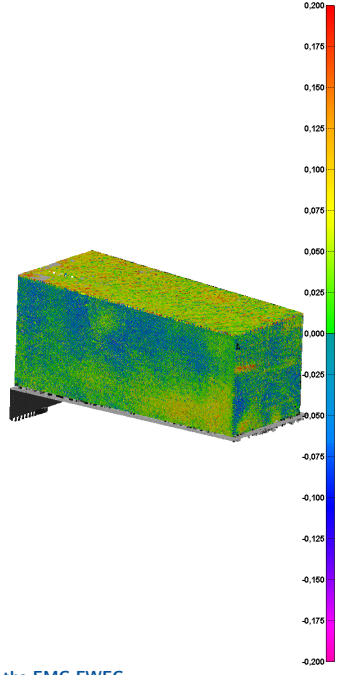
- Scan submodule on the backplate
- Select points of the frontface
- Create a mesh an use it as reference
- Import scan from table
- Select points of the frontface
- Align scan from table to reference using fit



Position Determination by Frontface

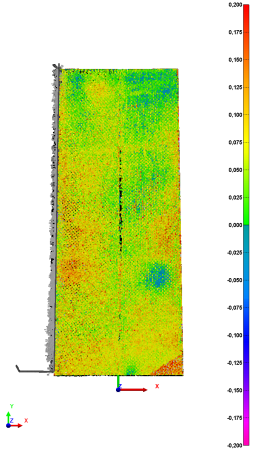
Procedure

- Scan submodule on the backplate
- Select points of the frontface
- Create a mesh an use it as reference
- Import scan from table
- Select points of the frontface
- Align scan from table to reference using fit
- Calculate angles to backplate using rotation of alignment and table measurement

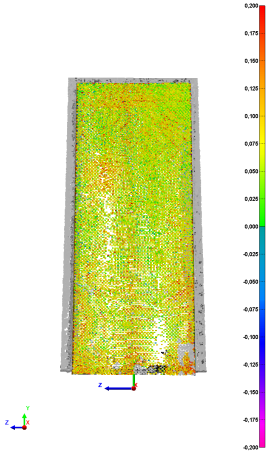


Difference between Backplate and Table Measurement

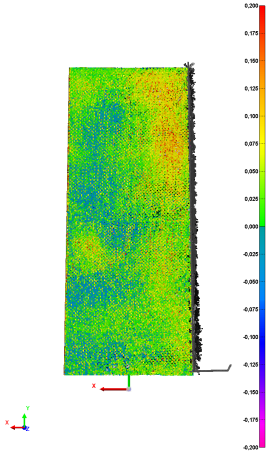
Left



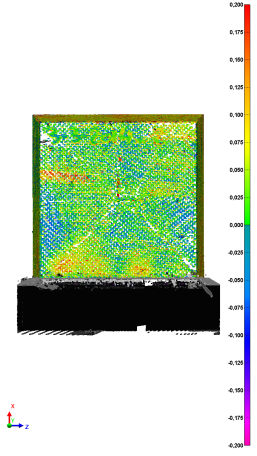
Top



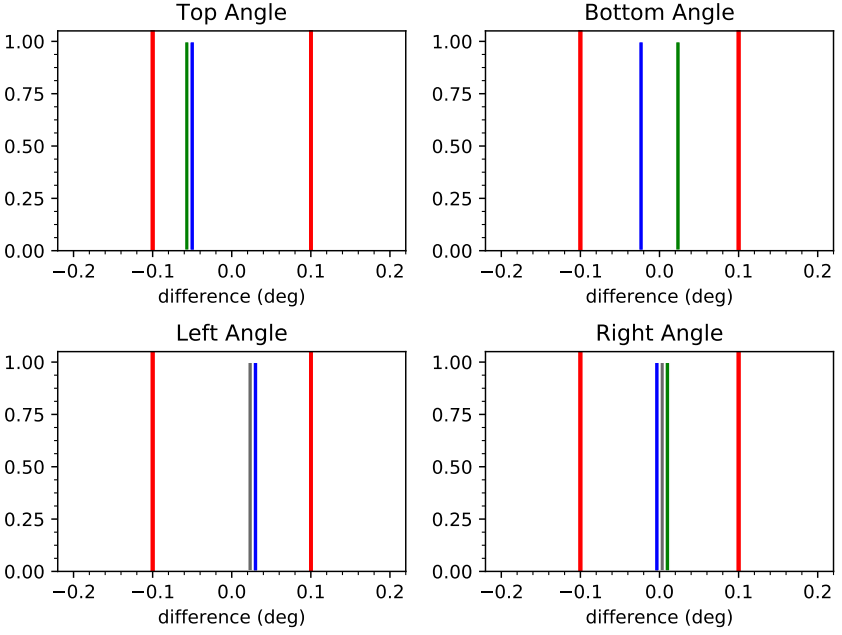
Right



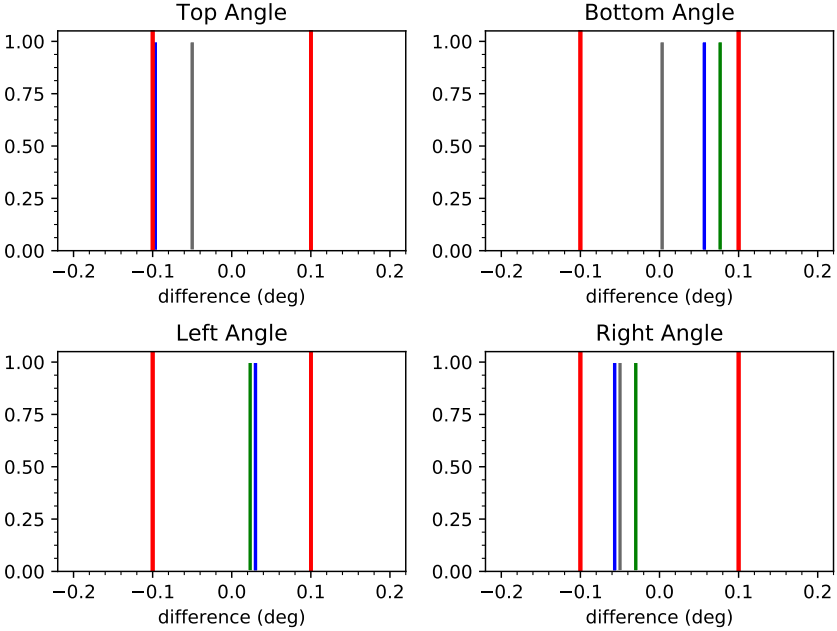
Front



Submodule 1-X4Y2

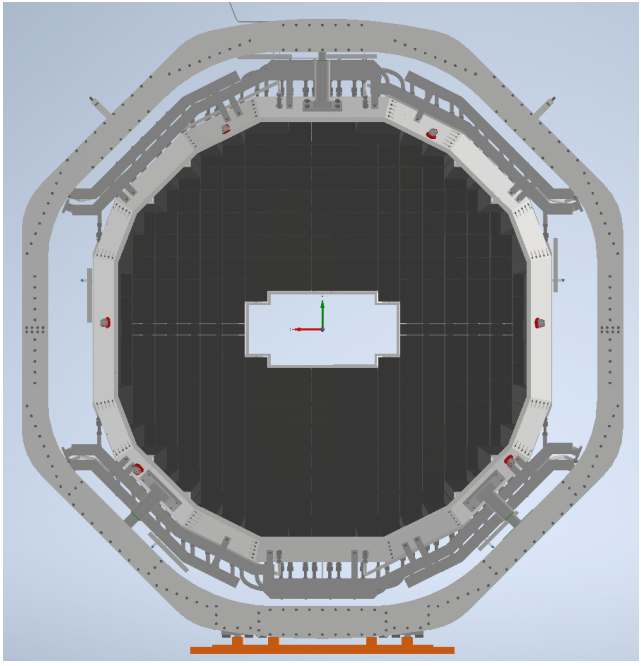


Submodule 4-X4Y1-R2



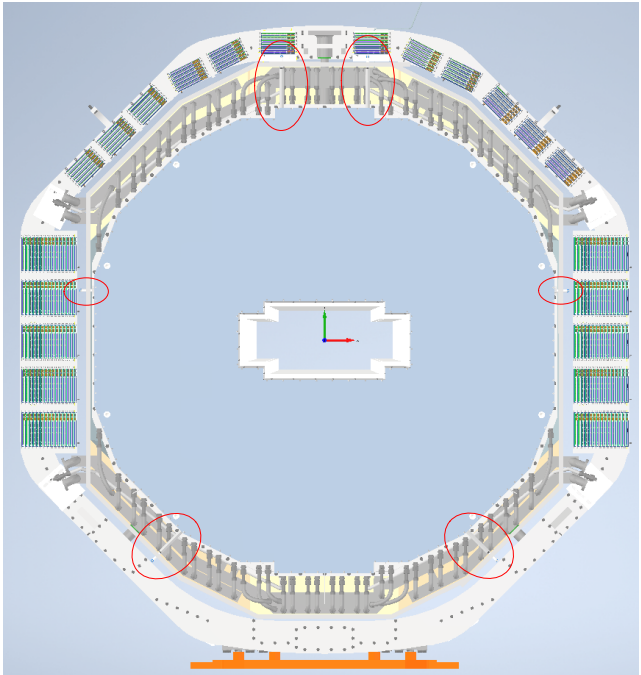
Position of the EMC Forward Endcap

Reflector mounts for the front of the FWEC



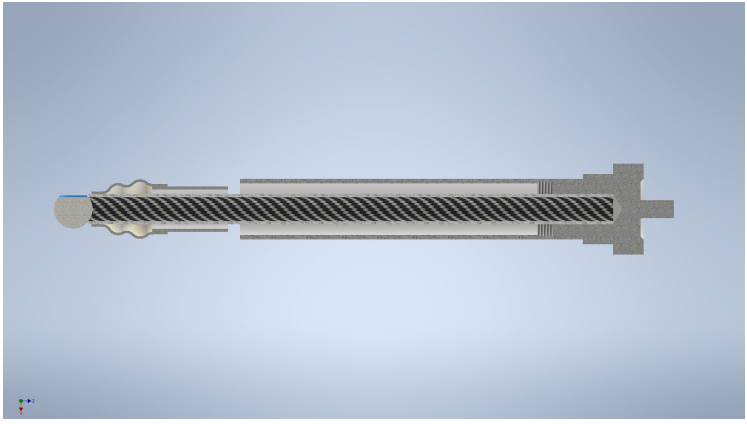
- Six bases for 1.5 inch reflectors
- Attached to the stiffener ring using glue or screws
- Removed when attaching the insulation
- Allows measurement of crystal fronts in a defined reference frame

Reflector mounts for the back of the FWEC



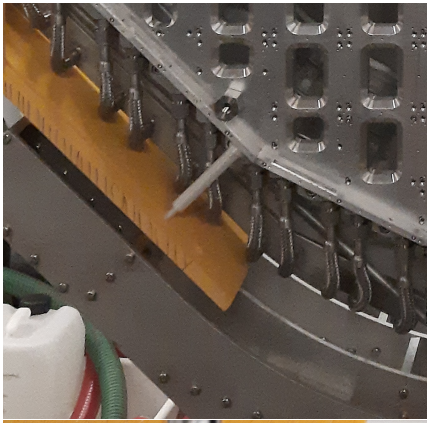
- Six permanently installed reflectors
- Visible from the back of the detector
- Attached to the backplate/electronics frame
- Penetrates the insulation in the cable slits
- Allows measurement of shrinkage and displacement during cooling

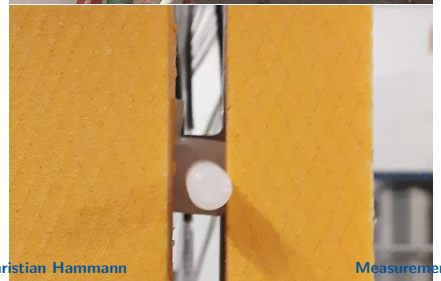
Reflector mounts - construction



- Reflector (0.5 inch - 12.7 mm)
- Carbon fiber tube (10 mm)
- Flexible bellows
- Cable guard
- Attachment to detector

Reflector mounts - Mounting Test





Summary

- Geometry of all submodules of EMC forward endcap is measured using Leica AT960 and T-Scan.
- Position of submodules on the endcap can be determined by the front face of the alveole.
- Reflector mounts are needed in the front of the endcap to measure the alveole faces.
- Reflectors visible from the back are needed to determine the position of the endcap.